

AD-A241 919

## JMENTATION PAGE

Form Approved  
GSA FPMR (41 CFR) 101-11.6

11. UNCLASSIFIED		15. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AND DECLASSIFICATION SCHEDULE NA		3. DISTRIBUTION/AVAILABILITY OF REPORT	
2b. DECLASSIFICATION/DOWNGRADING SCHEDULE NA		5. MONITORING ORGANIZATION REPORT NUMBER(S)	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) EX 22-91		7a. NAME OF MONITORING ORGANIZATION	
6a. NAME OF PERFORMING ORGANIZATION TEXCOM Fire Support Test Directorate		6b. OFFICE SYMBOL (If applicable) CSTE-TFS-T	
6c. ADDRESS (City, State, and ZIP Code) Fort Sill, OK 73503-6100		7b. ADDRESS (City, State, and ZIP Code)	
8a. NAME OF FUNDING, SPONSORING ORGANIZATION TRADOC		8b. OFFICE SYMBOL (If applicable) ATCD-R	
8c. ADDRESS (City, State, and ZIP Code) Fort Monroe, VA 23651-5000		9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
11. TITLE (Include Security Classification) BATTLEKING Evaluation, BK 22-91, Meteorological Sensor Package (MSP) (U)		10. SOURCE OF FUNDING NUMBERS	
12. PERSONAL AUTHOR(S) Johnson, Christine M., CPT		13a. TYPE OF REPORT Final	
13b. TIME COVERED FROM 910514 TO 910516		14. DATE OF REPORT (Year, Month, Day) 910924	
15. PAGE COUNT 16		16. SUPPLEMENTARY NOTATION NA	
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	Meteorological Sensor Package, BATTLEKING
19. ABSTRACT (Continue on reverse if necessary and identify by block number) Letter report covering the MSP BATTLEKING Evaluation conducted at Fort Sill, Oklahoma, 14-16 May 1991. The MSP was evaluated to determine if it could provide the data for a nine-line meteorological message and provide low-level wind data for the multiple-launch rocket system. The MSP produced a nine-line met message based on surface readings taken by the sensor assembly for wind direction, wind speed, temperature, and pressure. The MSP generated messages were compared to the meteorological data systems' messages. Although the suitability of the MSP, as an alternative to the MDS system, could not be thoroughly assessed, the MSP does provide an approximation of the current met effects as contrasted to the NATO standard of no wind direction, no wind speed, and standard temperature and pressure. (25) * Meteorological data, )			
20. DISTRIBUTION/AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS		21. ABSTRACT UNCLASSIFIED	
22a. NAME OF RESPONSIBLE INDIVIDUAL CPT Christine M. Johnson		22b. TELEPHONE (Include Area Code) (405) 351-4589/2309	
		22c. OFFICE SYMBOL CSTE-TFS-T	

91-13172



01 1011 048



DEPARTMENT OF THE ARMY  
TEST AND EXPERIMENTATION COMMAND  
FIRE SUPPORT TEST DIRECTORATE  
FORT SILL, OKLAHOMA 73503-6100

REPLY TO  
ATTENTION OF:

CSTE-CSTE-IFS (70-1r)

24 September 1991

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Letter Report, BATTLEKING Evaluation, BX 22-91, Meteorological Sensor Package (MSP)

1. REFERENCES:

a. Memorandum, Assistant Commandant, U.S. Army Field Artillery School, ATTN: ATSP-CPT, 16 April 1991, subject: Request BATTLEKING Assess the Meteorological Sensor Package (MSP).

b. USAFACFS Regulation 11-5, Army Programs, BATTLEKING Program, 29 March 1991.

c. FM 6-16-2, 15 January 1982, Tables for Artillery Meteorology (Visual) Ballistic Type 3 and Computer Messages and Limited Surface Observations.

2. PURPOSE: This evaluation will be used to determine if the MSP can be used as a possible backup to electronically produced meteorological (met) data, and as a candidate for providing the required low-level wind data for the Multiple Launch Rocket System (MLRS).

3. BACKGROUND: The U.S. Army Training and Doctrine Command (TRADOC) System Manager-Target Acquisition (TSM-TA) obtained the use of an MSP for this evaluation. The Test and Experimentation Command Fire Support Test Directorate (TEXCOM FSTD) was formally requested to conduct a customer test (CT) of the MSP on 16 April 1991.

4. DESCRIPTION:

a. The MSP is a portable, stand-alone tripod or mast-mountable met system that collects, processes, stores, and distributes met data. The measurement of the met parameters uses sensors that have no moving parts except the north seeker. The MSP features four major subsystems which can operate separately or as an integrated system: (1) the sensor assembly; (2) the data control unit/communication buffer module and keyboard; (3) the mechanical support hardware which includes the mast assembly (vehicular mounting), tripod (stand-alone), battery box, and antenna; (4) the ground base sensors which include precipitation and soil temperature at three depths. See figure 1, page 2.

b. The MSP requires one operator. The MSP can operate on vehicle power (North Atlantic Treaty Organization (NATO) plug), batteries (BA5590s), and alternating current (AC) power (115/220 volts).

CSTE-IFS-7

SUBJECT: Letter Report, BATTLEKING Evaluation, BK 22-91, Meteorological  
Sensor Package (MSP)

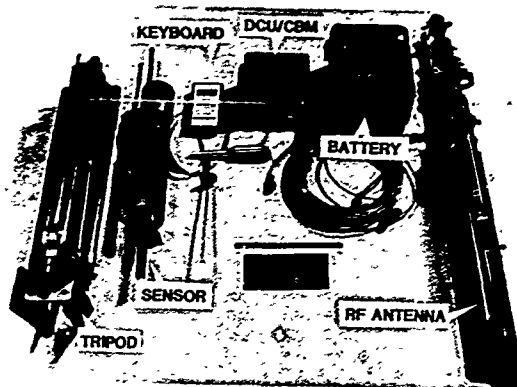


Figure 1. MSP components.



Figure 2. MSP on tripod mount.

CSIE-TFS-T

SUBJECT: Letter Report, BATTLEKING/Evaluation, EK 22-91, Meteorological Sensor Package (MSP)

c. The MSP, as configured for this evaluation, included the sensor assembly, the data control unit/communication buffer module, the battery box, and the tripod. See figure 2, page 2.

d. The MSP produces a nine-line met message based on operator input of initialization data and the sensor readings. The sensor assembly computes the vertical profile of the winds, temperatures, and pressures by extrapolation from surface measurements. The sensor assembly takes one sample per second. The operator can specify whether the MSP will take 1, 10, 30, or 60 samples to compute the met message.

e. Two modes of operation are possible: the one-point and the two-point. The one-point mode does not require data from an additional source. The two-point mode; however, requires wind speed and direction from line 03 of a meteorological data system (MDS) computer met message.

5. EVALUATION OBJECTIVES: Determine if the MSP can provide the data for a nine-line computer met message and provide low-level wind data for the MLRS.

#### 6. ISSUES AND CRITERIA:

a. Issue. Can the MSP provide the required data to develop a nine-line computer met message and NATO supplementary surface weather report (SUPREP) for artillery limited surface observation (ALSO)?

Criterion. None.

b. Issue. Can the MSP provide a measure of the low-level winds required by the MLRS?

Criterion. None.

NOTE: For the purpose of this evaluation, the Directorate of Combat Developments (DCD), U.S. Army Field Artillery School, defined the low-level winds as those from the surface to 100 meters above the surface.

#### 7. SCOPE AND TACTICAL CONTEXT:

a. Scope. The MSP was evaluated at Fort Sill, OK, 14-16 May 1991. The TEXCOM FSTD meteorological section performed all MSP operations. Data collected was compared to computer met messages produced by an MDS.

b. Tactical Context. The evaluation was conducted in a nontactical environment.

STATEMENT A PER TELECON  
CPT. CHRISTINE JOHNSON TEXCOM  
FIRE SUPPORT TEST DIRECTORATE  
ATTN: CSTE-TFS-T FT. SILL, OK  
73503-6100 NWW 10/22/91



Accession No.	✓
NTIS GRA&I	
DTIC TAB	
Unannounced	
Justification	
By	
Distribution/	
Availability Code	
Dist	Avail and/or Special
A-1	

CSTE-TFS-T

SUBJECT: Letter Report, BATTLEKING Evaluation, BX 22-91, Meteorological Sensor Package (MSP)

8. METHODOLOGY:

- a. The two issues were evaluated concurrently.
- b. Computer met message, DA Form 3677, and Limited Surface Observation, DA Form 5033-R, were used to collect data.
- c. Thirteen met missions were flown. Radiosondes were used in missions 1 and 4 while the pilot balloon (Pibal) method was used for the remaining 11 missions.
- d. One computer met message using the 60-sample option and one using the 10-sample option were produced by the MSP for each of the 13 missions. The one-point mode was used for missions 1 through 4 and the two-point mode was used for missions 5 through 13. See table 1 below.

TABLE 1. DATA COLLECTION

Mission	MDS method		MSP mode	
	Radiosonde	Pibal	60-sample	10-sample
1	X	--	-- <sup>a</sup>	X
2	--	X <sup>b</sup>	X	X
3	--	X	X	X
4	X	--	X	X
MSP two-point				
5	--	X	-- <sup>c</sup>	-- <sup>c</sup>
6	--	X	X	X
7	--	X	X	X
8	--	X	X	X
9	--	X	X	X
10	--	X	X	X
11	--	X	X	X
12	--	X	X	X
13	--	X	X	X

<sup>a</sup>Operator failed to properly initialize the MSP.

<sup>b</sup>Terminated after line 05 due to cloud cover.

<sup>c</sup>Operator failed to correctly input MDS line 03 data.

CSTE-TFS-T

SUBJECT: Letter Report, BATTLEKING Evaluation, BK 22-91, Meteorological Sensor Package (MSP)

e. The MDS produced a nine-line computer met message for each of the 13 missions. Wind direction, wind speed, temperature, and pressure from the MDS computer met messages were used as a baseline. The corresponding fields from the nine-line MSP generated computer met message were compared to the baseline. Additionally, MDS computed wind speed and direction (line 03) were used as input to the MSP when it was operated using the two-point mode.

f. The crew prepared a NATO SUPREP for missions 1 through 5 IAW FM 6-16-2. The wind speed, wind direction, temperature, and pressure for the SUPREPs were taken from line 00 of the corresponding MSP computer met messages.

## 9. RESULTS.

### a. Findings.

(1) Tables 2 through 5 show the means, standard deviations, sample sizes, and medians of the differences for each of the four major variables: wind direction, wind speed, temperature, and pressure for lines 00 through 09 for each mission flown. There were two instances of operator error which caused three MSP messages to be invalid. During mission 1, the operator failed to properly initialize the MSP for the 60-sample mode. During mission 5, the operator failed to correctly input MDS line 03 data for the MSP two-point procedures. Mission 2 was terminated after line 05 when clouds prevented tracking for lines 06, 07, 08, and 09.

TABLE 2. DIFFERENCE IN WIND DIRECTION IN MILS

Results	Mission numbers		
	1 and 4 <sup>a</sup>	2 and 3 <sup>b</sup>	6 through 13 <sup>c</sup>
Mean	-20.67	306.25	-90.50
Standard Deviation	351.78	428.60	278.36
Sample Size	30.00	32.00	160.00
Median	-110.00	345.00	-100.00

<sup>a</sup>Missions using radiosondes, MSP one-point mode.

<sup>b</sup>MSP one-point mode.

<sup>c</sup>MSP two-point mode.

CSFE-TFS-T

SUBJECT: Letter Report, BATTLEKING Evaluation, EK 22-91, Meteorological Sensor Package (MSP)

TABLE 3. DIFFERENCE IN WIND SPEED IN KNOTS

Results	Mission numbers		
	1 and 4 <sup>a</sup>	2 and 3 <sup>b</sup>	6 through 13 <sup>c</sup>
Mean	-54.27	-45.34	0.48
Standard Deviation	31.76	21.87	12.79
Sample Size	30.00	32.00	160.00
Median	-46.50	-43.50	0.00

<sup>a</sup>Missions using radiosondes, MSP one-point mode.

<sup>b</sup>MSP one-point mode.

<sup>c</sup>MSP two-point mode.

TABLE 4. DIFFERENCE IN TEMPERATURE IN DEGREES KELVIN

Results	Mission numbers		
	1 and 4 <sup>a</sup>	2 and 3 <sup>b</sup>	6 through 13 <sup>c</sup>
Mean	-2.01	5.91	7.98
Standard Deviation	1.13	4.71	3.57
Sample Size	30.00	32.00	160.00
Median	-1.50	6.70	9.70

<sup>a</sup>Missions using radiosondes, MSP one-point mode.

<sup>b</sup>MSP one-point mode.

<sup>c</sup>MSP two-point mode.

TABLE 5. DIFFERENCE IN PRESSURE IN MILLIBARS

Results	Mission numbers		
	1 and 4 <sup>a</sup>	2 and 3 <sup>b</sup>	6 through 13 <sup>c</sup>
Mean	0.17	44.84	47.08
Standard Deviation	0.58	31.96	26.17
Sample Size	30.00	32.00	160.00
Median	0.00	55.50	58.00

<sup>a</sup>Missions using radiosondes, MSP one-point mode.

<sup>b</sup>MSP one-point mode.

<sup>c</sup>MSP two-point mode.

CSIE-TFS-T

SUBJECT: Letter Report, BATTLEKING Evaluation, BK 22-91, Meteorological Sensor Package (MSP)

(2) Tables 6 and 7 show the mean difference between the MDS and MSP line 01 data for wind direction and speed. Line 01 represents the average from the surface to 200 meters altitude.

TABLE 6. DIFFERENCE IN LINE 01 WIND DIRECTION IN MILS

Results	Mission numbers		
	1 and 4 <sup>a</sup>	2 and 3 <sup>b</sup>	6 through 13 <sup>c</sup>
Mean	-210.00	-45.00	361.25
Standard Deviation	160.83	235.53	167.48
Sample Size	3.00	4.00	16.00
Median	-150.00	-50.00	355.00

<sup>a</sup>Missions with radiosondes, MSP one-point mode.

<sup>b</sup>MSP one-point mode.

<sup>c</sup>MSP two-point mode.

TABLE 7. DIFFERENCE IN LINE 01 WIND SPEED IN KNOTS

Results	Mission numbers		
	1 and 4 <sup>a</sup>	2 and 3 <sup>b</sup>	6 through 13 <sup>c</sup>
Mean	-37.00	-28.25	1.53
Standard Deviation	9.00	4.97	14.44
Sample Size	3.00	4.00	16.00
Median	-28.00	-28.50	-4.00

<sup>a</sup>Missions with radiosondes, MSP one-point mode.

<sup>b</sup>MSP one-point mode.

<sup>c</sup>MSP two-point mode.

b. Assessments. Sufficient data could not be obtained during the conduct of this BATTLEKING evaluation to determine the suitability of the MSP to provide data for a nine-line computer met message and NATO SUPREP due to the limited number of missions with radiosondes. Although the suitability of the MSP as an alternative to the MDS system could not be thoroughly assessed, the following observations are offered:

(1) The MSP is portable, lightweight, and operates with only one operator. Based on sensor obtained surface readings, it collects, processes, stores, and distributes met data.



CSTE-TFS-T

SUBJECT: Letter Report, BATTLEKING Evaluation, BK 22-91, Meteorological Sensor Package (MSP)

(2) The MSP produced a nine-line met message based on surface readings taken by the sensor assembly for wind direction, wind speed, temperature and pressure. Due to the limited number (two) of missions using a radiosonde, means testing was not done on the data obtained. However, greater differences between MDS and MSP data were obtained for wind direction and wind speed than for temperature and pressure. This did not hold true for the visual met missions where greater differences in pressure were observed.

(3) The MSP does provide an approximation of the current met effects as contrasted to the NATO standard of no wind direction, no wind speed, and standard temperature and pressure.

c. Recommendation: The MSP's suitability for measuring surface and low-level wind conditions warrants further testing.

10. SUGGESTED IMPROVEMENTS: None.

FOR THE DIRECTOR:

Encl  
Test Data

  
Dr. J. K. Kreitzer  
Technical Adviser

DISTRIBUTION:

BATTLEKING EXECUTIVE COMMITTEE

ASSISTANT COMMANDANT, U.S. ARMY FIELD ARTILLERY SCHOOL, ATTN: ATSF-A,  
FORT SILL, OK 73503-5600

COMMANDER, III CORPS ARTILLERY, ATTN: AFVI, FORT SILL, OK 73503-6000

DIRECTOR, DIRECTORATE OF COMBAT DEVELOPMENTS, U.S. ARMY FIELD ARTILLERY  
SCHOOL, ATTN: ATSF-CD, FORT SILL, OK 73503-5600

COMMANDER

U.S. ARMY TRAINING AND DOCTRINE COMMAND, ATTN: ATOS, FORT MONROE, VA  
23651-5000

HEADQUARTERS, TEST AND EXPERIMENTATION COMMAND, ATTN: CSTE-TMA,  
FORT HOOD, TX 76544-5065

ASSISTANT COMMANDANT

U.S. ARMY FIELD ARTILLERY SCHOOL, ATTN: ATSF-CPT, FORT SILL, OK 73503-5600

U.S. ARMY FIELD ARTILLERY SCHOOL, ATTN: USMC-LNO, FORT SILL, OK 73503-5600

CSTE-TFS-T

SUBJECT: Letter Report, BATTLEKING Evaluation, BK 22-91, Meteorological  
Sensor Package (MSP)

DISTRIBUTION: (CONT)  
DIRECTOR

ATMOSPHERIC SCIENCES LABORATORY, ATTN: SLCAS-AS-I, WHITE SANDS MISSILE RANGE,  
NM 88002-5501

TEXCOM FIRE SUPPORT TEST DIRECTORATE, ATTN: CSTE-TFS, FORT SILL, OK  
73503-6100

DEFENSE DOCUMENTATION CENTER, CAMERON STATION, ATTN: DPC-TCA, ALEXANDRIA,  
VA 22314-5000

# WIND DIRECTION MSP/HDS W/RADIOSONDE FLIGHTS 5/14/91

Wind Direction Number of miles change from MSP to HDS readings.

Net Line Number	0	1	2	3	4	5	6	7	8	9
Mission 1rb	-30	-150	-60	-160	-80	-140	-460	-160	20	540
Mission 4ra	-30	-50	-130	230	230	290	170	-250	630	940
Mission 4rb	-410	-430	-510	-150	-150	-90	-210	-630	250	560
Mean	-223.33	-210.00	-233.33	-26.67	0.00	20.00	-166.67	-346.67	300.00	680.00
Maximum	-30	-50	-60	230	230	290	170	-160	630	940
Minimum	-410	-430	-510	-160	-150	-140	-460	-630	20	540
Standard Deviation	155.21	160.83	197.71	181.54	165.13	192.01	259.02	203.69	251.53	184.03
Median	-150								Grand Median	-110.00

# WIND SPEED MSP/HDS W/RADIOSONDE FLIGHTS 5/14/91

Wind Speed Number of knots change from MSP to HDS readings (to the nearest knot).

Net Line Number	0	1	2	3	4	5	6	7	8	9
Mission 1rb	-5	-19	-20	-24	-32	-31	-40	-44	-47	-48
Mission 4ra	-6	-28	-37	-36	-46	-59	-69	-76	-81	-84
Mission 4rb	-14	-46	-60	-63	-75	-90	-102	-110	-116	-120
Mean	-10.00	-37.00	-48.50	-49.50	-60.50	-74.50	-70.33	-76.67	-81.33	-84.00
Maximum	-6	-28	-37	-36	-46	-59	-69	-76	-81	-84
Minimum	-14	-46	-60	-63	-75	-90	-102	-110	-116	-120
Standard Deviation	4.00	9.00	11.50	13.50	14.50	15.50	25.33	26.95	20.17	29.39
Median	-28								Grand Median	-46.5

TEMPERATURE MSP/MDS W/RADIOSONDE FLIGHTS 5/14/91  
Temperature difference between MSP to MDS readings (to the nearest 1/10 deg K).

Plot Line Number	0	1	2	3	4	5	6	7	8	9
Mission 1rb	-3.6	-3.0	-2.6	-1.3	-0.9	-0.5	-0.1	-0.1	-0.9	-1.4
Mission 4ra	-3.1	-4.0	-2.6	-1.5	-1.5	-1.5	-2.1	-1.0	-0.9	-1.4
Mission 4rb	-3.6	-4.1	-2.5	-1.5	-1.6	-1.5	-1.1	-1.0	-1.4	-1.9
Mean	-3.43	-3.70	-2.37	-1.43	-1.37	-1.17	-2.43	-1.00	-1.53	-1.73
Maximum	-3.1	-3.0	-2.5	-1.3	-0.9	-0.5	-1.1	-1.0	-0.9	-1.4
Minimum	-3.6	-4.1	-2.6	-1.5	-1.6	-1.5	-2.1	-1.0	-1.4	-1.9
Standard Deviation	0.24	0.50	0.05	0.09	0.33	0.47	1.89	0.00	0.24	0.24
Median										

-1.5

PRESSURE MSP/MDS W/RADIOSONDE FLIGHTS 5/14/91

Pressure difference between MSP to MDS readings (to the nearest mb).

Plot Line Number	0	1	2	3	4	5	6	7	8	9
Mission 1rb	0	0	0	0	0	0	0	-1	0	-1
Mission 4ra	1	1	1	1	0	0	0	0	-1	0
Mission 4rb	1	1	1	1	0	0	0	0	0	0
Mean	0.67	0.67	0.67	0.33	0.00	0.00	0.33	-0.33	-0.33	-0.33
Maximum	1	1	1	1	1	1	1	1	1	1
Minimum	0	0	0	0	0	0	0	0	0	0
Standard Deviation	0.47	0.47	0.47	0.47	0.00	0.00	0.47	0.47	0.47	0.47
Median										

0

# WIND DIRECTION MSP/MDS W/PIBAL FLIGHTS 5/14/91

Wind Direction Number of mile change from MSP to MDS readings.

Met Line Number	0	1	2	3	4	5	6	7	8	9
Mission 2pa	-440	210	540	500	670	510				
Mission 2pb	-480	170	500	460	630	470				
Mission 3pa	-500	-290	180	240	330	340	190	430	810	1500
Mission 3pb	-480	270	200	260	350	360	210	450	830	1220
Mean	-475.00	-45.00	355.00	365.00	495.00	420.00	200.00	440.00	820.00	1210.00
Maximum	-440	210	540	500	670	510	210	450	830	1220
Minimum	-500	-290	180	240	330	340	190	430	810	1500
Standard Deviation	21.79	235.53	165.76	116.08	155.60	71.76	10.00	10.00	10.00	10.00
Median		-50							Grand Median	

345

# WIND SPEED MSP/MDS W/PIBAL FLIGHTS 5/14/91

Wind Speed Number of knots change from MSP to MDS readings (to the nearest knot).

Met Line Number	0	1	2	3	4	5	6	7	8	9
Mission 2pa	-6	-21	-27	-34	-42	-47				
Mission 2pb	-10	-20	-36	-44	-54	-57				
Mission 3pa	-12	-35	-38	-43	-54	-58	-61	-72	-79	-82
Mission 3pb	-9	-29	-30	-34	-46	-53	-61	-67	-70	-73
Mean	-9.25	-28.25	-32.75	-30.75	-49.50	-56.75	-66.50	-73.00	-76.00	-79.50
Maximum	-6	-21	-27	-34	-42	-47	-61	-67	-70	-73
Minimum	-12	-35	-38	-43	-54	-58	-72	-79	-82	-86
Standard Deviation	2.17	4.97	4.44	4.76	5.72	6.87	5.50	6.00	6.00	6.50
Median		-28.5							Grand Median	

-43.5

# TEMPERATURE MSP/MDS W/PIDAL FLIGHTS 5/14/91

Temperature difference between MSP to MDS readings (to the nearest 1/10 deg C).

Met Line Number	0	1	2	3	4	5	6	7	8	9
Mission 2pa	1.3	-0.4	2.5	5.8	0.1	9.7				
Mission 2pb	1.1	0.5	2.5	5.8	0.1	9.7				
Mission 3pa	-0.2	-1.4	2.1	5.3	7.6	9.3	9.4	16.0	9.3	9.2
Mission 3pb	-0.9	-1.6	2.4	5.6	7.8	9.5	9.7	16.3	9.5	9.5
Mean	0.35	-0.73	2.38	5.63	7.90	9.95	9.55	16.15	9.40	9.35
Maximum	1	1	3	6	8	10	10	16	10	10
Minimum	-1	-2	2	3	8	9	9	16	9	9
Standard Deviation	0.91	0.84	0.16	0.20	0.21	0.17	0.15	0.15	0.10	0.15
Median									Grand Median	

6.7

# PRESSURE MSP/MDS W/PIDAL FLIGHTS 5/14/91

Pressure difference between MSP to MDS readings (to the nearest mb).

Met Line Number	0	1	2	3	4	5	6	7	8	9
Mission 2pa	0	0	22	53	73	129				
Mission 2pb	0	0	22	53	73	69				
Mission 3pa	1	1	23	53	74	70	67	63	60	50
Mission 3pb	1	1	23	53	74	70	67	63	61	50
Mean	0.50	0.50	22.50	53.00	73.50	84.50	67.00	63.00	60.50	50.00
Maximum	1	1	23	53	74	129	67	63	61	50
Minimum	0	0	22	53	73	69	67	63	60	50
Standard Deviation	0.50	0.50	0.50	0.00	0.50	25.70	0.00	0.00	0.50	0.00
Median									Grand Median	

55.5

# WIND DIRECTION MSP/HDS W/PIBAL FLIGHTS 5/16/91

Wind Direction Number of mile change from MSP to HDS readings.

Net Line Number	0	1	2	3	4	5	6	7	8	9
Mission 6A	-240	510	240	0	-160	-190	-270	-520	-470	-280
Mission 6B	-420	350	130	0	-160	-180	-270	-520	-470	-280
Mission 7A	-10	510	260	0	0	60	-140	-470	-510	-280
Mission 7B	-40	480	240	0	0	60	-140	-470	-510	-280
Mission 8A	-200	340	210	0	0	-80	-200	-470	-630	-650
Mission 8B	-190	350	210	0	-250	-80	-200	-470	-630	-650
Mission 9A	-270	350	210	0	-10	-40	-400	-520	-630	-570
Mission 9B	30	630	380	0	-10	-40	-400	-520	-630	-570
Mission 10A	170	260	240	0	240	-280	-370	-500	-380	-180
Mission 10B	-20	90	140	0	240	-280	-370	-500	-380	-180
Mission 11A	-270	540	440	0	-30	-160	-130	-140	-210	-160
Mission 11B	-270	540	440	0	-30	-160	-130	-140	-210	-160
Mission 12A	-20	240	120	0	-110	-170	-200	-130	-140	-210
Mission 12B	-190	90	30	0	-110	-170	-200	-130	-140	-210
Mission 13A	40	80	190	0	-60	-100	-110	-50	-60	-100
Mission 13B	420	410	370	0	-60	-100	-110	-50	-60	-100
Mean	-96.25	361.25	243.13	0.00	-6.13	-118.75	-230.00	-350.00	-378.75	-303.75
Maximum	420	630	440	0	240	-160	-110	-50	-60	-100
Minimum	-420	80	30	0	-10	-280	-400	-570	-630	-650
Standard Deviation	203.19	167.48	112.96	0.00	2.34	96.23	106.30	190.92	205.82	186.48
Median	355								Grand Median	

# WIND SPEED MSP/MDS W/PIBAL FLIGHTS 5/16/91

Wind Speed Number of Knots change from MSP to MDS readings (to the nearest Int).

Mot Line Number	0	1	2	3	4	5	6	7	8	9
Mission 6a	-19	-16	-14	-7	16	13	13	9	11	12
Mission 6b	-20	-13	-8	0	23	21	17	17	19	22
Mission 7a	-14	-2	6	0	-2	4	3	-1	12	0
Mission 7b	-17	-3	5	0	-2	4	4	0	13	2
Mission 8a	-17	-11	4	0	-23	-17	-7	-7	10	-8
Mission 8b	-16	-11	4	0	-23	-17	-7	-7	10	-8
Mission 9a	-9	-9	-4	0	2	-1	4	11	24	16
Mission 9b	-12	-11	-5	0	2	0	5	12	26	17
Mission 10a	-16	-6	-3	0	-3	4	8	18	9	9
Mission 10b	-11	-3	3	0	4	9	9	19	10	10
Mission 11a	-14	6	3	0	4	0	8	14	24	17
Mission 11b	-12	6	3	0	4	0	8	14	24	17
Mission 12a	-2	2	12	0	-11	-17	-20	-13	-14	-21
Mission 12b	-19	8	13	0	-11	-17	-20	-13	-14	-21
Mission 13a	4	8	19	0	-6	-10	-10	-5	-6	-10
Mission 13b	42	41	39	0	-6	-10	-11	-5	-6	-10
Mean	-9.13	1.53	5.00	0.00	-3.67	-3.47	-0.56	3.94	9.50	2.75
Maximum	-12	-11	-8	0	23	21	13	19	26	22
Minimum	-20	-13	-8	0	-23	-17	-20	-13	-14	-21
Standard Deviation	14.95	14.44	11.24	0.00	10.85	10.59	10.21	11.04	12.75	13.75
Median	-4	-4	-4	-4	-4	-4	-4	-4	-4	-4
Grand Median										



TEMPERATURE HSP/HDS W/PIDAL FLIGHTS 5/16/71  
Temperature difference between HSP to HDS readings (to the nearest 1/10 deg K).

Mit Line Number	0	1	2	3	4	5	6	7	8	9
Mission 6a	-0.2	1.9	0.9	0.7	0.6	0.6	0.4	9.0	9.0	8.9
Mission 6b	0.1	2.4	7.2	0.7	0.7	0.7	0.7	9.3	9.3	9.2
Mission 7a	1.8	4.1	9.7	10.7	10.7	10.7	10.4	11.0	11.0	10.9
Mission 7b	1.2	3.6	8.7	10.4	10.4	10.4	10.1	10.7	10.7	10.6
Mission 8a	0.5	2.9	8.0	9.7	9.7	9.7	9.4	9.7	9.7	9.7
Mission 8b	0.7	3.1	8.1	9.8	9.7	9.7	9.5	10.7	10.9	9.7
Mission 9a	0.8	3.3	8.4	10.1	10.0	10.0	9.8	10.3	10.4	10.2
Mission 9b	0.3	2.9	11.2	9.9	9.8	9.8	9.6	10.7	10.1	10.0
Mission 10a	0.2	0.3	8.7	10.4	10.3	10.4	10.1	10.7	10.2	10.2
Mission 10b	-0.1	2.8	8.6	10.2	10.1	10.2	9.9	10.5	10.4	10.3
Mission 11a	-0.4	2.6	8.4	10.0	9.9	10.0	9.7	10.4	10.4	10.3
Mission 11b	-0.4	2.6	8.4	10.0	9.9	10.0	9.7	10.4	10.4	10.3
Mission 12a	-0.3	2.7	8.5	10.3	10.2	10.2	9.9	10.5	10.4	10.3
Mission 12b	-0.5	2.6	8.4	10.1	10.1	10.1	9.8	10.4	10.5	10.3
Mission 13a	-1.6	1.6	7.5	9.3	9.2	9.3	9.0	9.6	9.7	9.6
Mission 13b	-1.6	1.6	7.5	9.3	9.2	9.3	9.0	9.6	9.7	9.6
Mean	0.01	2.56	0.34	9.87	9.79	9.84	9.56	10.19	9.53	10.08
Maximum	1.8	4.1	11.2	10.7	10.7	10.7	10.4	11.0	11.0	10.9
Minimum	-1.6	0.3	6.9	8.7	8.6	8.6	8.4	9.0	0.6	8.9
Standard Deviation	0.87	0.87	0.93	0.53	0.55	0.55	0.53	0.55	2.36	0.53
									Grand Median	9.7

PRESSURE MSP/MDS W/PIBAL FLIGHTS 5/16/91  
Pressure difference between MSP to MDS readings (to the nearest mb).

MSP Line Number	0	1	2	3	4	5	6	7	8	9
Mission 6a	1	1	2	2	2	2	2	2	2	2
Mission 6b	1	1	1	1	1	1	1	1	1	1
Mission 7a	1	1	1	1	1	1	1	1	1	1
Mission 7b	1	1	1	1	1	1	1	1	1	1
Mission 8a	1	1	1	1	1	1	1	1	1	1
Mission 8b	1	1	1	1	1	1	1	1	1	1
Mission 9a	1	1	1	1	1	1	1	1	1	1
Mission 9b	1	1	1	1	1	1	1	1	1	1
Mission 10a	1	1	1	1	1	1	1	1	1	1
Mission 10b	1	1	1	1	1	1	1	1	1	1
Mission 11a	1	1	1	1	1	1	1	1	1	1
Mission 11b	1	1	1	1	1	1	1	1	1	1
Mission 12a	1	1	1	1	1	1	1	1	1	1
Mission 12b	1	1	1	1	1	1	1	1	1	1
Mission 13a	1	1	1	1	1	1	1	1	1	1
Mission 13b	1	1	1	1	1	1	1	1	1	1
Mean	1.75	2.00	23.00	54.13	73.88	70.00	66.56	63.13	59.75	56.56
Maximum	2	2	23	55	74	71	67	63	60	57
Minimum	1	2	23	54	73	69	66	63	59	56
Standard Deviation	0.43	0.00	0.00	0.33	0.33	0.50	0.50	0.33	0.43	0.50
									Grand Median	